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Some observations on the
Ecology of the Etosha Game
Park, South West Africa .

Introduction

The Etosha Game Park, also known as the Etosha Pan Game Reserve, Namutoni Game Reserve, Game Reserve No. 2, or simply as the Etosha Pan, is situated in the northern part of South West Africa approximately between 14° and 17° E. and 18° 30'–19° 30' S. (map 1). It is bounded by farms in the south and east and by the Ovamboland and Kaokoveld Native Reserves in the north and west respectively.

The Park was proclaimed by the German governor of the time, von Lindequist, on 22nd March, 1907, and the proclamation took effect on 1st May of that year. The country surrounding the Etosha Pan as well as the whole of the Kaokoveld became *Wildschutzgebiet* Nr. 2 and it is still officially termed Game Reserve No. 2 (*S.W.A. Gazette*, 1958a). The latter designation is applied to a somewhat smaller tract of country than that defined by the 1907 proclamation however, for parts of the old *Wildschutzgebiet* were excised for farming purposes as the Territory developed. Despite the official nomenclature, the Etosha Game Park, the boundaries of which were recently defined by the Game Parks and Private Game Reserves Ordinance (*S.W.A. Gazette*, 1958b), has been under the control of the Game Conservation Section of the S.W.A. Administration for some time. The Kaokoveld Native Reserve is administered by the Department of Native Affairs.

It is with the Etosha Game Park *sensu stricto*, an area of some 8,500 square miles, that this paper is concerned (map 1). The observations recorded here were made during the period April 1956 to March 1958 when the writer was employed by the Game Conservation Section and stationed in the Park. Most of them were included in two unpublished annual reports submitted to the Administration.

Topography and Soils

Wellington (1955) distinguishes the Kalahari Basin as one of the main physiographic regions of Southern Africa and divides it, mainly on hydrographical grounds, into three sub-regions: the Southern Kalahari, the Northern Kalahari and the Etosha Basin. Most of

the Park falls within the latter although parts of it merge into the adjoining sub-region known as the Chela-Otavi Highlands, which is characterised by Otavi dolomite with karst features.

The central feature of the Park is the Etosha Pan which has an elevation of roughly 3,500 feet above sea-level. It is 60-70 miles long, from south-west to north-east, and about 30 miles broad, with a floor of sandy clay, saline in parts, particularly along the southern edge. Wellington (loc. cit.) describes its water relations as follows: "The pan is the end-basin of the drainage coming mainly from the north, but an affluent from the east, the Omuramba Ovambo, brings a small volume of water to the pan in most years. As we have seen the pan lies in a structural basin, the Ovashimba highlands (over 5,000 feet above sea-level) of Otavi Sandstones and conglomerates bound the basin to the west, and the Otavi limestone rises gradually southwards to 4,500 feet. There is no rock surface to the east, where the basin is bounded by a sand swelling in the Omaheke sandveld about 600 feet above the pan floor. North of the pan the sandveld rises very gently towards the Ovamboland administrative centre Ondangua, the gradient being of the order of 2 feet to the mile."

The Etosha Pan is usually dry and desolate. The last time it was entirely covered with water is said to have been in 1934. However in most years the eastern part near Namutoni holds water for several months after the end of the rains. Jaeger (1926-7) also mentions this and I was able to observe it in two successive years. In 1957 shallow water (1½-2 feet) remained until July while in 1958 it dried up a few months earlier. This water is brought down by the Omuramba Ovambo which would seem to be the only drainage channel with a large and regular flow.

Because of the nature of the surface south of the pan—Otavi limestone with shallow turfy soil in places—most of the rainwater soaks away and there is little drainage from that direction. From the west too only a negligible quantity of water enters the pan, probably because of the absence of channels. The Ekuma river comes from the north and enters the Etosha Pan at its north-west corner. But in normal years it does not appear to bring down much water, a fact already noticed by Jaeger (loc. cit.) who states "Ueberhaupt haben die Missionare vom Westufer aus niemals Wasser auf der Pflanze gesehen, und die Ovambo bestaetigen dies . . ." The very gentle gradient north of the pan is probably the main reason.

For the most part the Park is characterised by extreme flatness. The outliers of the Kaokoveld highlands are situated near the western boundary and a few small koppies occur on the southern border. Half-way between Okaukuejo and Namutoni and 7 miles south of the pan Tweekoppies form a prominent landmark. These isolated hills of Otavi dolomite are approximately 300 feet higher than the surrounding country. Shallow depressions in the form of meandering omurambas (dry watercourses) to the south and small pans to the west of the Etosha Pan are a feature of the landscape.

The soils of the Park can only be described in the broadest of terms as they have not yet been studied in detail. Limestone covers much of the ground surface south of the Etosha Pan and there is little soil in this region. What there is, is shallow, grey, poor in humus and powdery, becoming sticky when wet. In depressions it is deeper, black and turfy. Soil of a similar nature extends across the southern part of the western sector of the Park, i.e. from the southern boundary up to the vicinity of the 19° line of latitude. Here limestone outcrops are not so common or so extensive. Northwards the grey soil merges into grey Kalahari sand which stretches from the 19th parallel to the border of the Park and beyond into Ovamboland. Reddish to greyish white Kalahari sand is also found in the north-eastern corner from Namutoni to the northern and eastern limits of the Park.

Climate

Meteorological data are available in the form of rainfall records from Okaukuejo and Namutoni, formerly police posts and recently also tourist camps (Table 1).

TABLE 1.
Total annual rainfall (mm.) recorded at Okaukuejo and Namutoni.

Year	Okaukuejo	Namutoni	Year	Okaukuejo	Namutoni
1922	—	220·0	1940	515·6	257·9
1923	—	709·2	1941	348·8	—
1924	—	385·2	1942	604·3	—
1925	—	600·7	1943	294·9	—
1926	—	449·7	1944	595·1	—
1927	—	329·0	1945	453·4	445·6
1928	—	—	1946	184·4	90·4
1929	—	342·9	1947	523·4	416·9
1930	—	284·7	1948	302·7	552·3
1931	—	467·2	1949	424·4	281·2
1932	—	—	1950	821·7	975·4
1933	—	256·3	1951	460·8	546·9
1934	827·5	633·8	1952	292·3	304·1
1935	306·1	375·7	1953	389·6	523·9
1936	316·1	324·9	1954	676·9	696·5
1937	349·0	608·4	1955	296·4	391·9
1938	594·2	—	1956	438·1	588·5
1939	498·1	554·9	1957	478·6	546·7

— denotes no records available.

The mean annual rainfall at Okaukuejo, calculated for 24 years, is 458 mm. with a standard deviation of 162.9. That at Namutoni, computed from the records for 29 years, is 453.8 mm. with a standard deviation of 180.1. Fluctuations about the mean are thus considerable and reflect the unpredictability and irregularity of the rainfall.

In most years the rains commence in October (very rarely in September or November) and continue until April (very rarely until March or May). The precipitation in each month of the rainy season is shown in Table 2.

TABLE 2.
Mean monthly rainfall (mm.) at Okaukuejo and Namutoni, rainy season.

Month	Okaukuejo (mean of 24 years)	Namutoni (mean of 29 years)
October	13·5	16·6
November	33·5	42·6
December	92·3	76·6
January	90·1	88·7
February	115·4	99·2
March	83·1	86·1
April	27·5	26·5

The Park, like most of the Territory, is thus a summer rainfall area with almost completely dry winters.

Unfortunately temperature and humidity have not been recorded. Temperatures are high during the summer and frost occurs frequently during the winter months. The daily range of temperature is also considerable at all times of the year.

Vegetation

The vegetation of the Park is poorly known. This account is thus of necessity very broad and incomplete. It is based partly on an unpublished departmental report (Joubert, 1956) prepared by the Pasture Research Officer of the Department of Agriculture, modified by the present writer. Joubert has distinguished four main types of vegetation. These will be dealt with in turn.

Type 1. Plains around the Etosha Pan

This zone has very few bushes or trees and consists of a mixture of grass and low shrubs or karroid scrub. It is a sparse pioneer community with a low basal cover and grows on a powdery lime soil poor in humus. Only in the south-western extension of type 1 do we find trees and bushes.

The plains border the pan in the south, east and west, occasionally attaining a width of three or four miles. We do not yet know whether they also occur along the northern margin. From the Okaukuejo-Okondeka road this vegetation type extends for 30-40 miles to the complex of small pans west of the Etosha pan. It forms the area known as Groot Vlake (map 1). Here scattered belts of Mopane (*Colophospermum mopane*), Slapdoring (*Acacia glandulifera*) and Gabbabos (*Catophractes alexandri*) interrupt the plains in places but the composition of the ground layer remains essentially constant.

The grasses are short and widely spaced. Common species include *Enneapogon brachystachyus*, *Aristida curvata* and in places *Eragrostis denudata*. The first two are annuals. However *E. brachystachyus* gives the impression of being a perennial because of the persistence of the old plants through the dry season. They produce basal spikelets which remain enclosed, drop to the ground and, in the following spring, germinate and grow up through the remaining basal tuft of the parent plant (Stopp, 1958). A taller perennial common near Okaukuejo is *Monelytrum luderitzianum*.

These grasses and the ephemeral forbs which spring up are heavily grazed in the Groot Vlake area during the rainy season, when game concentrates there in large numbers. It is during the growing period that annuals have a high feeding value whereas during the dry months they contain little or no nutriment. In this respect, as is well known, they differ from perennial grasses. Walter and Volk (1954) have summarised the difference as follows: "Bei den ausdauernden Graesern (perennials) . . . wandert nur ein Teil der Nachrstoffe in die Fruechte, waehrend der andere Teil in den Halmen oder Wurzelstoecken gespeichert wird, die so auch in der 'kalten Zeit' den Weidetieren wertvolles Futter bieten koennen. Einjaehrige Graeser (annuals) sind nur im gruenen oder halb-reifen Zustand fuer die Ernaehrung der Tiere von Bedeutung, nach dem Absamen liefern sie nur noch Ballastfutter." In addition it seems likely that the annual species are more palatable in summer than are the perennials, since they lack the tough remains of the plants of the previous year from which the latter start their new growth.

In addition to the common grasses to which mention has been made, pure stands of coarse quick grass, possibly a *Cynodon* species, occur in restricted areas near the edge of the pan, as for instance in the vicinity of Okondeka.

The common small—12-18 inch high—bushes of vegetation type 1 are *Leucosphaera bainesii*, *Cyathula* sp., *Petalidium (englerianum?)* and *Justicia* sp. Locally, dense, pure stands of a *Salsola* sp. are encountered and in saline depressions *Suaeda* is a common halophyte.

Along the western border of the pan a leguminous shrub becomes dominant. On slightly elevated ground, small coppices of *Acacia glandulifera* (Slapdoring) about 6-8 feet high are characteristic. *Aloe rubrolutea* grows over large areas; it is a conspicuous element in the landscape along the road from Okaukejo to Namutoni.

Type 2. Andoni flats and extensions of the Pan

The vegetation of the Andoni flats, which is the only extensive area with this type in the Park, is a very simple halophytic community of perennial grasses where bushes and trees are absent. Both the soil—grey Kalahari sand—and the plant cover are essentially the same as those of the adjoining plains of southern Ovamboland. Since Andoni is level there is little surface runoff and this presumably accounts for the high salinity which seems to control the nature of the vegetation.

Type 3. Northern perennial long-grass veld

This is savannah with the perennials *Antheophora pubescens*, *Schmidtia bulbosa*, *Heteropogon contortus* and *Aristida uniplumis* dominating the grass layer, while Mopane (*Colophospermum mopane*) in both tall and dwarf forms is the commonest tree. Patches of *Catophractes alexandri* (Gabbabos) and *Acacia glandulifera* (Slapdoring) are encountered locally, *Terminalia prunioides* (Deurmekaarbos) is a fairly common tree and the Witgatboom, *Boscia albitrunca*, occurs. In the deeper soil of depressions fine specimens of Hardekool (*Combretum imberbe*) and *Acacia* (probably *hebeclada*) are found.

Much of the Mopane attains a height of only about 4 feet and is commonly referred to as the "dwarf form". Joubert (loc. cit.) has suggested that this may be due to the prevalence of veld fires which often sweep into the Park from Ovamboland. Another possible reason is seen by Dr. Martin (personal communication) in the fact that the ground water here is usually strongly saline.

This savannah type occupies that part of the western section of the Park where Kalahari sand occurs, i.e. from the north-western corner of Etosha Pan westwards, presumably right to the western border (which I did not visit) and south to about the 19th parallel of latitude. South of this line it merges into the southern savannah.

Type 4. Southern perennial long-grass veld with Mopane

Related to the northern type this community grows on stonier, shallower soil of a different character where surface limestone outcrops are a feature. There are thus more pioneer species in the ground layer. The main grasses are *Triraphis ramosissima*, *Antheophora pubescens* and *Aristida uniplumis*; *Fingerhuthia africana* is also present, particularly on surface limestone. Local pockets of black turf soil occur, where dense stands of tall *Aristida meridionalis* and sometimes of *Eragrostis superba* are prominent.

The Mopane is by far the commonest tree and dominates the landscape. It does grow in the "dwarf form" but is usually found as a medium-sized tree (about 15 feet) in park-like woodland or as a medium to large tree (15-25 feet) in dense groves. In places the Deurmekaarbos (*Terminalia prunioides*) and a *Combretum*, probably *apiculatum*, are numerous and sometimes co-dominant with Mopane. Gabbabos (*C. alexandri*) is fairly widespread, especially on raised ground. On deeper soils and near waterholes the Hardekool (*Combretum imberbe*) is found.

As described thus far, vegetation of type 4 occurs

- (a) in the south-western section of the Park, south of 19° S. and west of the Groot Vlakke. Here it is rather dry and the trees tend to be smaller; dense stands of *Acacia*

detinens are encountered and Gabbabos is rather more prominent than in the other areas;

- (b) south of the Etosha Pan to the border of the Park, excluding the area described under (c). This is the most typical form of the type;
- (c) in the extreme eastern section of the Park, in the vicinity of Namutoni and for some distance south of this camp, a modified form of the southern savannah becomes dominant. The upper layer is a tall, thick woodland in which Mopane is very scarce; *Spirostachys africanus* (Tambooti), *Commiphora* spp. (Kannidood), *Deurmekaarbos* and *Hardekool* replace it. Wild figs (*Ficus* sp.) and *Acacias*, probably mostly *hebeclada*, occur, the latter sometimes alone. Large outcrops of limestone cover much of the ground surface;
- (d) north of Namutoni another variation of type 4 extends up to the southern edge of the Andoni flats. On the deep reddish-yellow sand Appelblaar (*Lonchocarpus capassa*), *Terminalia prunioides*, *T. sericea* and *Commiphora* spp. are conspicuous trees; the widespread *Catophractes alexandri* also grows here but groves of tall *Acacia detinens* tend to replace it. The grasses are mainly perennial species.

The southern perennial long-grass veld is the most varied vegetation type in the Park and closer study may show that it requires subdivision. However it will be considered as one with the four sub-types listed above for this paper, mainly because of the uniformity of the grass layer.

Water

The location and availability of surface water in an arid area such as the Park is an ecological factor of major importance. For most of the year the animals are dependent on the permanent waterholes, natural and artificial. Consequently their distribution is decisively influenced by the position of these drinking places.

From map 1 it is apparent that the majority of the permanent waterholes are situated along the southern edge of the Etosha Pan and in the adjacent southern savannah (vegetation type 4). Some 20 large springs and numerous smaller ones are found on or near the pan margin. The water is saline in almost all cases and salt crusts are deposited around the sides. Scattered tufts of a member of the *Cyperaceae* ("biesies") grow near them. In the southern savannah we find about 18 waterholes—the number is approximate because the area has not been fully explored—and two windmills. The natural holes vary in size and in the amount of water produced. They are all permanent except perhaps in very dry years. Many are set in crater-like depressions and most are surrounded by a dense growth of reeds and other aquatic plants. In nearly all cases the water is sulphurous.

The eastern edge of the pan has 3 natural springs while according to Jaeger (loc. cit.) there is no permanent water on the northern side. Andoni, an artesian spring opened up by drilling in the course of prospecting operations some 30 years ago, is the only water available on the Andoni flats throughout the year.

The section of the Park west of the Etosha Pan is very poorly supplied with drinking places. There are 5 widely separated natural holes—Okondeka on the pan edge, Narawandu, Okakuamburu, Onaiso and Okatjongeama—and the four windmills at Okahakana, Adamax, Leobrunn and Grünewald.

During the rainy season there is more surface water than in the dry months. This is particularly the case in the otherwise poorly watered western section, where there are numerous small pans and hollows. The Natukanaoka pan and its outliers running across Groot Vlake assume great importance in summer as we shall see in the next section.

Game Movements

As far as can be ascertained, Fischer (1914) was the first to publish a description of game migration in the area now called the Etosha Game Park. By migration I mean a regular annual shift of the bulk of a population from one area to another and back. He writes that the grazing grounds in the vicinity of the Etosha Pan were deserted, sometimes almost overnight, by zebra, gemsbok and springbok when they migrated westward after the first good rains. According to his account hartebeest and kudu did not migrate, while wildebeest moved eastward. Shortridge (1927) described the same phenomenon as follows: "That (the rainy season) is the time when a large percentage of Burchell's Zebra, Wildebeest, Hartebeest, etc., leave the permanent springs in the Namutoni Game Reserve in search of fresh grazing grounds—supplementing those (animals) that may be more or less resident in Ovamboland and elsewhere". He made further reference to the migration in a later work (Shortridge, 1934).

In this section my own observations and some quantitative data on the migration will be presented and an attempt will be made to relate it to environmental factors. The accompanying maps should be used as adjuncts to the text. Map 1 is a general one showing the rest camps, roads and larger waterholes. In map 2 the Park has been tentatively and approximately divided into several zones. Different patterns of shading distinguish the dry season concentration area (d.s.c.a.), wet season dispersal area (w.s.d.a.) and probable wet season dispersal area (p.w.s.d.a.). The Namutoni area and the Andoni flats do not appear to be referable to any of these heads and will thus be treated separately. Areas the status of which is doubtful or unknown we left blank.

Broadly speaking, the differences between the distribution of game in the dry and in the wet season may be stated as follows: During the dry season the majority of the zebra (*Equus burchelli antiquorum* H. Smith), wildebeest (*Connochaetes (Gorgon) t. taurinus* Burchell) and springbok (*Antidorcas marsupialis* Zimm.) by far the most abundant ungulates—are concentrated around the permanent waterholes east of the Outjo-Okaukuejo road. This has been designated the d.s.c.a. After the onset of the rains most of these animals migrate to grazing grounds west of the road where they are probably joined by migrants from Ovamboland. This has been called the w.s.d.a. and it is thought to include the country labelled p.w.s.d.a. Here they drop their calves, lambs and foals. Gemsbok (*Oryx g. gazella* Linn.) and giraffe (*Giraffa camelopardalis* Linn.), which are fairly evenly distributed over both d.s.c.a. and w.s.d.a. during the dry months, become scarce in the latter during the rainy season. Their movements at this time are not understood. Eland (*Taurotragus o. oryx* Pallas) also appear to change their grazing grounds but even less is known about their behaviour.

This simple statement of the position requires some qualification. From a meteorological point of view the dry season extends from May to September and the rainy season from October to April. However we cannot apply these terms absolutely to game migrations. It will be shown that a typical "dry season distribution" may persist until well after the commencement of the rainy season *sensu stricto* and that a "wet season distribution" may cease before the end of the rainy season proper.

The following comparison between the observations made during the dry seasons of 1956 and 1957 on the one hand and during the wet seasons of 1956-7 and 1957-8 on the other, will serve to illustrate the seasonal differences in distribution. The operative word is "illustrate", for the composite picture I have of the migration has been built up from innumerable small incidents and general impressions which cannot all be reproduced here.

Dry Season

(a) D.S.C.A.

Game counts were made at four of the waterholes in this area. The results are summarised in Table 3.

TABLE 3.

Dry Season Waterhole Counts.
Dry Season Concentration Area.

Date	Place and Period	Z	Wb	Sp	Gb	K	H	Gir	Whg
17-7-56 ..	Ombika 15.10-18.30	c160	—	1	—	19	—	—	7
12-11-57 ..	10.00-18.15	c165	2	c60	—	16	—	—	3
14-11-57 ..	10.15-18.20	c150	7	c95	11	7	—	2	11
22-8-56 ..	Gemsbokvlakte 09.45-12.30	c280	—	41	34	3	—	—	—
15-10-56 ..	Ondongab 10.00-17.30	111	57	31	64	—	—	11	—
7-12-56 ..	09.15-19.00	c90	61	c350	92	—	1	1	—
11-7-57 ..	10.30-18.15	64	—	45	38	—	1	—	—
15-7-57 ..	10.40-17.30	42	9	57	77	—	—	—	—
16-7-57 ..	09.50-17.50	25	9	43	82	—	1	—	—
17-7-57 ..	10.50-15.45	27	25	54	101	6	—	—	—
18-7-57 ..	10.10-17.25	44	10	43	91	6	—	—	—
19-7-57 ..	09.50-17.25	27	10	53	75	7	—	—	—
14-9-56 ..	Kapupuhedi 08.00-16.00	c100	56	12	c49	—	—	—	—
12-10-56 ..	09.30-16.25	c345	5	60	32	—	—	—	—
23-10-56 ..	09.00-16.25	c275	—	87	90	2	—	—	—
16-11-56 ..	09.15-17.25	104	44	—	61	—	—	—	—
17-7-57 ..	09.30-16.00	109	—	27	37	—	—	—	—
19-7-57 ..	09.20-17.35	c100	—	39	42	—	—	—	—

Abbreviations:

Z — zebra

Gb = gemsbok

Gir = giraffe

Wb = wildebeest

K — kudu

Whg = warthog

Sp = springbok

H = hartebeest

c = approximately

They show that zebra, wildebeest, springbok and gemsbok are the dominant species and give a rough indication of the population of a small part of the Park, perhaps 70 square miles in extent. Counts made from the road following various routes give an impression of game numbers over a wider area (Table 4).

TABLE 4
Dry Season Road Counts.
Dry Season Concentration Area.

Date	Route and Distance	Z	Wb	Sp	Gb	K	H	Ed	Gir
18-7-56	On-Kap-Ok .. 15m.	98	c105	c80	69	6	—	—	—
25-7-56	Ok-Kap-On-H-Nam rd. 30m.	c350	c450	c250	17	—	2	—	10
1-8-56	Ok-Kap-On-G .. 24m.	c530	c80	109	53	—	—	—	6
30-7-57	Ok-Obk-Go-Nam rd. 75m.	c400	83	c190	21	47	c40	c60	—
9-11-57	Ok-Kap-On .. 15m.	61	c175	20	c70	—	1	—	—
18-11-57	Ok-Kap-On-Riet .. 33m.	20	c170	257	43	—	—	—	—
18-11-57	Riet-On-Kap-Ok ..	37	c290	c130	c70	—	—	—	4
30-7-57	Ok-Nam* .. 84m.	c445	c380	c520	3	4	11	—	2
	(a) Ok-Kap-On-Riet	c70	c90	c370	3	—	11	—	—
	(b) Riet-Nam .. 51m.	c375	c290	c150	—	4	—	—	2

Abbreviations:

Game species as in Table 3; Ed — eland.

On = Ondongab

Kap = Kapupuhedi

Ok = Okaukuejo

H = Homob

Nam rd. = Namutoni road

G = Gunuob

Obk = Ombika

Go = Gobaub

Riet = Rietfontein

Nam = Namutoni

The same conclusion can be drawn from these results, viz. one sees more zebra, wildebeest, springbok and gemsbok than any other hoofed animals. The data collected along the Okaukuejo-Kapupuhedi-Ondongab-Homob-Namutoni road route, a distance of only 30 miles, on 25-7-56 provides a good instance of how abundant they are in some places. Giraffe are generally encountered in small parties. Eland and hartebeest (*Alcelaphus buselaphus selbornei* Lyd.) numbers appear from Table 4 to be very low. This is not a fair picture of the position for they occur in sizeable herds at several southerly waterholes which are not included in the Table because no counts were made there.

It should perhaps be noted here that road counts are of very little use in calculating population density per unit area in the Park. During the day the majority of the animals seen along the southern edge of the pan are at the waterholes. This is probably because their feeding grounds extend away from the water in only one direction, the pan being practically bare. They seem to spend the night in the southern grassveld, come to water from about 8-9 a.m. and remain nearby for the rest of the day until 4-5 p.m. Day counts thus show concentrations at the waterholes and most of the intervening country appears empty.

(b) W.S.D.A.

The game population here is distinctly different from that of the d.s.c.a. Counts made at waterholes and from the roads during two successive dry seasons are set out in Tables 5 and 6.

*Note: The figures for the count along the Okaukuejo-Namutoni road do not include game seen within 8-10 miles of Namutoni. That area is dealt with separately from the d.s.c.a.

TABLE 5.

Dry Season Waterhole Counts.
Wet Season Dispersal Area.

Date	Place and Period	Z	Wb	Sp	Gb	Ed	Gir	Whg
17-10-56	Adamax wm. .. a	—	—	c85	c65	—	11	—
17-10-56	Grünewald wm. .. a	15	—	c200	90	6	—	3
8-10-57	Grünewald wm. .. a	c70	1	c150	c80	17	—	—
11-11-57	Okondeka.. .. a	—	—	c90	—	—	—	—
10-8-57	Okahakana wm. .. a	—	—	10	—	—	—	—
10-9-57	Okahakana wm. .. a	—	—	18	11	—	—	—
8-10-57	Okahakana wm. .. a	—	—	—	4	—	—	—

Abbreviations:

Game species as in Tables 3 and 4.

wm. = windmill; a = counted on arrival, no time spent watching.

TABLE 6.

Dry Season Road Counts.
Wet Season Dispersal Area.

Date	Route and Distance	Z	Wb	Sp	Gb	Ed	Gir
4-5-57	Ok-Grünewald .. 30m.	—	—	c175	c50	—	32
10-5-57	Ok-Grünewald .. 30m.	—	—	c125	115	1	—
10-10-57	Ok-Grünewald .. 30m.	c25	—	c160	c50	20	12
8-11-57	Ok-Grünewald .. 30m.	—	—	—	c35	1	7
3-10-57	Grünewald-Groot Vlakte .. 10m.	38	—	c195	c20	1	—
25-10-57	Okondeka-Adamax- Grünewald* .. 28m.	6	—	c150	c75	—	4
19-11-56	Ok-Okondeka .. 14m.	4	17	c500	2	—	—
18-12-56	Ok-Okondeka .. 14m.	14	16	c590	4	—	—
25-10-57	Ok-Okondeka .. 14m.	—	—	c140	11	—	—
31-10-57	Ok-Okondeka .. 14m.	—	2	c250	10	—	—
2-11-57	Ok-Okondeka .. 14m.	8	—	c480	58	—	—

Abbreviations:

Game species as in Tables 3 and 4; localities as in Table 4.

*Note: Game at Okondeka waterhole excluded.

We see that gemsbok and springbok are the only large ungulates found in any quantity. Zebra and wildebeest, so common in the d.s.c.a., are very scarce. Furthermore, and this is not apparent from the Tables, most of the zebra occur at Grünwald windmill, which is on the border between the short-grass plains of Groot Vlake and a strip of southern perennial-grass savannah. They graze mainly in the latter area. A small herd of eland, also at Grünwald, were the only representatives of the species seen in the w.s.d.a. in two dry seasons. Giraffe numbers seem to be at about the same level as in the d.s.c.a.

(c) P.W.S.D.A.

Although we do not know this area well, the indications are that its game population is similar to that of the w.s.d.a. during the dry season but smaller. In June, 1957, before the road that now runs along the 19th parallel (map 1) had been built, an exploratory cross-country journey of about 35 miles was made from Adamax westward approximately along the present course of the road. The vegetation was northern perennial-grass savannah, no surface water was found and only a few small herds of gemsbok, one of hartebeest and one of giraffe were encountered. Some fresh eland spoor was also seen.

(d) Areas of doubtful status.

Two other accessible parts of the western portion of the Park, falling within the areas left blank on map 2, were visited during the dry season only. The first is traversed by the Okondeka-Okotomare-Ovamboland road. Once the country served by Okondeka, which extends about 13 miles from the waterhole, is left behind, one generally finds only a few ostrich (*Struthio camelus* Linn.) and occasionally a few gemsbok. The second is that through which the Okahakana-Narawandu-Ovamboland road passes. This I saw on two occasions; only a few springbok, gemsbok and hartebeest, and once a troop of three lions (*Panthera leo* Linn.) were recorded. On the whole then, the game population is probably similar to that of the p.w.s.d.a. but perhaps even smaller.

The entire north-western sector of the Park was inaccessible at the time of this study. I did not get to the waterholes Okatjongeama, Onaiso and Okakuamburu and consequently cannot provide any information on the game there.

Wet Season

(a) D.S.C.A.

Unfortunately only a little data was collected in 1956-7. Game numbers were lower than in dry weather at the waterholes visited. Thus zebra drinking at Kapupuhedi over a 7-8 hour period declined from 104 on 16th November, 1956, to 23 on 20th November and 10 on 22nd November. Only 25 wildebeest and 2 springbok were seen at Gemsbokvlakte on 13th January, 1957, whereas 250-300 zebra and smaller groups of springbok and gemsbok were almost invariably to be found there in the dry months. On 27th February, 1957, only 21 zebra came to Ondongab in 4½ hours (cf. Table 3).

The results of counts made during the 1957-8 rains give a clearer picture of game numbers over a bigger area (Table 7).

TABLE 7.

Wet Season Road Counts.
Dry Season Concentration Area.

Date	Route and Distance	Z	Wb	Sp	Gb	K	H	Ed	Gir
20-12-57	Ok-Nam* 84m.	c940	c373	c458	55	9	16	—	—
	(a) Ok-Riet .. 33m.	c780	c350	c450	51	—	12	—	—
	(b) Riet-Nam .. 51m.	c160	23	8	4	9	4	—	—
18-1-58	Ok-Nam	11	c250	c295	17	4	7	—	3
	(a) Ok-Riet	11	c175	c295	7	—	—	—	—
	(b) Riet-Nam	—	c75	—	10	4	7	—	3
19-1-58	Nam-Ok	—	c290	5	16	10	21	—	13
	(a) Nam-Riet	—	c100	—	—	6	—	—	5
	(b) Riet-Ok	—	c190	5	16	4	21	—	8
14-2-58	Ok-Nam	—	c174	c112	113	—	26	—	6
	(a) Ok-Riet	—	c160	2	113	—	24	—	6
	(b) Riet-Nam	—	14	c110	—	—	2	—	—
15-2-58	Nam-Ok	—	c335	1	c75	25	10	—	—
	(a) Nam-Riet	—	25	1	—	24	—	—	—
	(b) Riet-Ok	—	c310	—	c75	1	10	—	—
7-3-58	Gemsbokvlakte-On 9m.	409	25	—	2	3	—	—	—
7-3-58	On-Ok 15m.	215	6	—	8	—	—	—	—
8-3-58	Ok-On 15m.	c715	21	—	10	—	—	—	—
9-3-58	Ok-Nam	c1,820	c295	c180	15	c52	—	4	5
	(a) Ok-Riet	c1,350	c130	c175	12	c15	—	4	5
	(b) Riet-Nam	c470	c165	5	3	37	—	—	—
9-3-58	Nam-Ok	c1,615	c130	c55	9	9	—	—	—
	(a) Nam-Riet	c570	c100	—	—	9	—	—	—
	(b) Riet-Ok	c1,045	c30	c55	9	—	—	—	—

Abbreviations:

Game species as in Tables 3 and 4; localities as in Table 4.

Excluding those counts dated December and March for a moment, it is obvious that the zebra population had slumped. The abundance of the species in December is rather striking and unexpected however. As the w.s.d.a. was already populated by migrants at this time, it is probable that those seen in the d.s.c.a. on 20th December were late-comers about to move westward. This supposition is supported by the fact that on that date many more were found between Okaukuejo and Rietfontein than in the eastern sector between Rietfontein and Namutoni. In the dry season (30-7-57, Table 4) the opposite was the case. The March counts were made at a time when migrants were returning to the d.s.c.a. and they will be dealt with below.

Turning now to other species, Table 7 shows that on the whole wildebeest and springbok

*Note: The figures for all the counts along the Okaukuejo-Namutoni road do not include game seen within 8-10 miles of Namutoni. That area is dealt with separately from the d.s.c.a.

numbers declined during the rains, but the drop was not as spectacular as for zebra. It was noticed that most of the former two animals counted from the Okaukuejo-Namutoni road in January and February were concentrated about 3 miles west of Rietfontein. Here the plains bordering the pan (vegetation type I) extend southward to form a fairly large enclave in the savannah. The vegetation is very similar to that of the w.s.d.a., which may account for so many of the antelope remaining there.

Gemsbok and giraffe were found at about the same level of abundance as during the dry months.

(b) W.S.D.A.

On 28th December, 1956, the usual dry season population was found on the short-grass plains of the w.s.d.a. but there were small herds of zebra at Leobrunn. These and the wildebeest seen earlier (19-11, 18-12, Table 6) near Okondeka indicated the commencement of westward migration. The next visit took place on 14th February, 1957. An impressive change in the game population was apparent. Between Okaukuejo and Leobrunn and thence to the Groot Vlake herds of zebra, wildebeest and springbok were numerous and widely spread. Very few gemsbok and giraffe were seen however. On the Groot Vlake the total of the three migrant species was estimated at 10,000 head. The scene was one to be remembered—green grass, rainwater-filled pans and an incessant noise caused by mothers and their offspring calling constantly to each other.

Conditions were very much the same on 22nd February, but by this time the grasses and forbs showed signs of drying up and many of the rainwater pools were empty. On 25th February I found that the Groot Vlake had been abandoned and only a few springbok and ostriches, about 20 gemsbok and 1 wildebeest were counted. By using binoculars, however, a dark mass of game could be distinguished on the northern edge of the plain. Flying over the area on the same day the Chief Game Warden saw several thousand head of wildebeest and lesser herds of zebra and springbok trekking fast along deeply trodden paths leading E.N.E. They appeared to be passing north of Adamax and making for the pans west of Okondeka where water and grazing was still plentiful.

In the triangle between Okaukuejo, Okondeka and Adamax, migratory game was present in small numbers during January and February, 1957. In March there was an influx. Thus on 10th March approximately 2,000 wildebeest and 1,000 zebra were in sight along the first 5 miles of the Okaukuejo-Okondeka road. On the same day several hundred wildebeest and rather fewer zebra were grazing near the Okondeka-Adamax road and masses of wildebeest could be seen at the pans to the north, whither they had trekked on 25th February. From Leobrunn to Okaukuejo all three species were encountered in good numbers and one remarkable herd of c2,000 springbok was recorded.

From 15th March, when some 1,000 wildebeest, 900 springbok and 33 zebra were counted about the Okaukuejo airfield, numbers began to drop. On 9th April a tally made on the Okaukuejo-Okondeka road gave a total of 300 zebra, 20 wildebeest, 25 springbok and 2 gemsbok. The end of April also marked the end of the wet season pattern of game distribution.

To summarise, migrants began to appear in the w.s.d.a. in December, 1956. We do not know when the main herds arrived but by mid-February, 1957, the Groot Vlake was densely populated. Towards the end of that month game moved away from the Groot Vlake to areas where water and grazing was still available, without leaving the w.s.d.a. however. Game density declined during April and by the end of the month the migration was over.

The pattern followed in the 1957-58 rains differed somewhat in detail. After the first shower (9.5 mm.) had fallen at Okaukuejo on 20th October, 1957, we rather expected migration to start immediately. Investigation showed that the daily trek to the waterholes in the d.s.c.a. was checked for a few days but the game soon reverted to its normal routine. Green grass

near Ondongab, where precipitation must have been higher than elsewhere, brought about a minor temporary concentration of migratory species which dispersed when the grass dried. There was at this time no change in the population of the w.s.d.a., nor was it possible to establish when the influx into that zone started. However, by 27th November, 1957, zebra, wildebeest and springbok were already numerous, as the following field notes show:

			Z	Wb	Sp	Gb	Lion	Ostrich
Ok-Okondeka	..	..	65	c280	c920	2	7	323
Okondeka-Adamax	..	..	—	c240	c1,240	—	—	—
Groot Vlake	..	..	c75	c450	c650	—	—	c40
Leobrunn-Ok	..	..	c50	c110	c750	4	2	—

The relative smallness of the zebra herds may be correlated with our suggestion (see under (a) above) that they migrated late. It is noteworthy that so very few gemsbok and no giraffe were seen (cf. Table 6).

TABLE 8.
Wet Season Game Counts.
Wet Season Dispersal Area.

Date	Route and Distance	Z	Wb	Sp	Gb	K	H	Gir
8-1-58	Ok - Okondeka - 4 miles along Adamax road .. 18m.	c90	c1,185	c1,360	3	—	—	—
24-1-58	Ok-Leobrunn (out) 12m. (return)	c270 c125	c225 c115	c35 17	—	—	—	—
24-1-58	Leobrunn-Adamax (out) 7m. (return)	— 7	c200 c50	c300 c450	3	—	—	4 5
24-1-58	Adamax along northern edge of Groot Vlake .. c10m. (return)	c50 —	c500 c335	c40 c355	1 3	—	—	—
24-1-58	Road to west through Perennial savannah (p.w.s.d.a. map 2) (out) c40m. (return)	— —	— —	—	25 23	— 2	10 10	— —
8-2-58	Ok-Okondeka 14m.	5	183	c730	c80	—	—	—
8-2-58	Ok-Adamax 9m.	c95	c490	c995	—	—	—	—
8-2-58	Adamax-eastern edge of Groot Vlake c8m.	c370	c650	—	—	—	—	—
19-2-58	Ok-Leobrunn 12m.	20	c535	c75	—	—	—	—
19-2-58	Leobrunn-eastern edge of Groot Vlake 15m.	c250	c295	c2,050	1	—	—	—
19-2-58	Groot Vlake c150	c150	c500	c70	1	—	—	—
19-2-58	Groot Vlake-Adamax .. c8m.	c150	c200	—	—	—	—	—
19-2-58	Adamax Windmill	—	—	—	29	—	—	—
22-2-58	Ok-Leobrunn	c40	c950	—	1	—	—	—

Abbreviations:

Game species as in Tables 3 and 4; localities as in Table 4.

Various counts made later in the rainy season (Table 8) show that migratory species were well represented all over the w.s.d.a. Once again they were accompanied by new-born young in profusion. However we did not observe a concentration on the Groot Vlakke comparable with that of February, 1957. The reason is speculative. A congregation may have occurred and not been seen or conditions may have been simultaneously favourable over a larger area than in 1957, in which case the animals would probably have been more widely dispersed. Gemsbok and giraffe numbers were generally much lower than in the dry season and no eland were seen.

The first intimation that migrants were leaving the west was given by a report from a passing official. On 7th March, 1958, he travelled from Ovamboland to Okaukuejo along the western edge of the pan and saw big herds of wildebeest trekking northwards towards the Native Reserve. On the same day numbers of zebra were observed moving eastwards in the country between Okondeka and Okaukuejo.

I was fortunate in being able to watch large troops of zebra returning to the d.s.c.a. on 7th, 8th and 9th March (Table 7). They moved eastwards along the southern margin of the Etosha Pan and travelled steadily, although at no more than a fast walk, strung out in Indian file in long lines. Paths several inches deep were left where they had passed. Many grazed as they walked and a good percentage of the mares had young foals.

The bulk of the game had left the w.s.d.a. by 19th March, when only 160 wildebeest, 41 zebra and 13 springbok were recorded between Okaukuejo-Okondeka and Leobrunn. Thus the 1957-8 migration started some time in November and ended in March.

(c) P.W.S.D.A.

This area has been separated from the w.s.d.a. as we have only a little information by which to judge its status. On 2nd January, 1958, a grader operator returned to Okaukuejo after making a road from Adamax across the northern part of Groot Vlakke and through this zone. He had progressed for about 50 miles when he was forced to stop work because of heavy rains. He reported that game, apparently chiefly zebra and wildebeest, had been plentiful along his route. Unfortunately the condition of the road prevented me from following this lead. However, his report tallies with my own observations in June, 1957, when the same general area was explored. Old zebra and wildebeest tracks and droppings, the consistency of the latter suggesting that the animals had been eating green grass, were then found to be plentiful. When this sector was patrolled on 24th January (Table 8, "road to west through perennial savannah") the herds reported at the beginning of the month were not seen but by then the country was dry.

It is on this circumstantial evidence that I have tentatively designated the country concerned a probable w.s.d.a. Further work may well show that it is a part of the w.s.d.a. proper.

Discussion

The two successive migrations differ mainly in the time at which they took place. The first started late in December, 1956, and the animals left the w.s.d.a. in April, 1957. The second got under way early in November, 1957, and the return trek of the bulk of the game took place early in March of the following year. An analysis of the rainfall at Okaukuejo, which gives some indication of that in the adjacent parts of the Park, shows similar differences in the two periods (Table 9).

TABLE 9.
Analysis of rainfall (mm.) at Okaukuejo.

Month	Mean of 24 years	1956-7		1957-8	
		Actual rainfall	Rainfall as % of mean	Actual rainfall	Rainfall as % of mean
October	13.5	0	0%	9.5	70.4%
November	33.5	21.5	64.2%	91.8	274.0%
December	92.3	32.5	35.2%	115.7	125.4%
January	90.1	77.8	86.3%	101.9	113.1%
February	115.4	104.3	90.4%	70.9	61.4%
(a) February 1-15	—	—	—	67.4	—
(b) February 16-28	—	—	—	3.5	—
March	83.1	65.1	78.4%	?	?
(a) March 1-10	—	39.0	—	2.3	—
(b) March 11-31	—	26.1	—	?	?
April	27.5	10.9	39.6%	?	?

The fall in November, 1956, was low, that of the following month somewhat higher (absolutely) but well below the mean. Only from January to March, 1957, did the total precipitation approach the mean values for those months while April was relatively dry again. Very heavy rain was recorded in November, 1957, and above-average totals were attained in December and January, 1958. The figures for February and March are the most interesting however. From 16th February until 10th March only 5.8 mm. was registered, which dovetails neatly with our observation that emigration from the w.s.d.a. started on 7th March.

There would thus seem to be a correlation between rainfall and migration. This suggests that migrants alternate between two distinct regions because of food and water requirements. A working hypothesis has been built up on this basis, and it appears to fit the facts. We assume that the typically migratory species, zebra, wildebeest and springbok, prefer young green grass and forbs to other types of food. These are most readily obtainable in the w.s.d.a. during the rainy season, since the dominant grasses there are annuals. The d.s.c.a. has mainly long perennial grass and when new shoots appear they grow from the tussocks left over from the previous year. Thus quantities of tough fibrous old material must be ingested with the green shoots and the animals find grazing in the w.s.d.a. more palatable. In the dry months however the pasture of the w.s.d.a. has, on the whole, a very low feeding value while that of the d.s.c.a. retains a good deal of nutriment. Most of the game therefore concentrates in the latter zone. The fact that pans of fresh water are found throughout the w.s.d.a. during the rains, whereas it is not well watered for the rest of the year, may add to its attractiveness. On the other hand, the availability of water cannot be the prime factor causing the migration. There are windmills in the w.s.d.a. which pump throughout the year, yet game only increases in the rains. Conversely, the d.s.c.a. is well watered all the year round but its population drops during the wet months.

This hypothesis may oversimplify the picture. Factors such as the psychological preferences of game and differences in the trace elements found in various areas may yet prove to be of importance. The fact that parturition takes place in the w.s.d.a. may be another contributory cause. However, research on the behaviour of other ungulates lends support



to the view that alimantal factors are of great significance in causing seasonal movements. Thus Fraser Darling (1937) found that red deer (*Cervus elaphus*) forsake the hills of the Scottish highlands for the valleys when snow falls, partly at least because snow covers their food plants. Similarly the extensive migration carried out by elk (*Cervus canadensis*) between highlands and lowlands in parts of America is closely related to the presence of snow on the former (Altmann, 1952). In summer the lush green pastures of the highlands stand in contrast to dry conditions in the lowlands. Buffalo (*Bison bison*) "returned to the higher meadows again with the disappearance of snow in May or June" (McHugh, 1958).

Molloy (1957) has given a graphic description of the movement of white-eared kob, tiang, eland, etc., estimated at a million head, from the dry-weather grazing grounds on the Pibor and Akobo Rivers southwards to the Topotha plains in S.E. Sudan after the onset of the rains. He writes: "There has been much speculation over the cause of this movement, but it seems fairly clear that the basic motive is a search for grazing, while flooding of the upper Nile plains in the rear may be a secondary cause." Vesey-Fitzgerald (1954) considers grazing and water to be the main factors which cause the plains' game (wildebeest, hartebeest, zebra, Thomson's and Grant's gazelle) of the Athi-Kapiti plains in Kenya to alternate between dry season concentration areas and wet season dispersal areas. Finally, we may point to the Serengeti plains in Tanganyika, "dry grasslands, verdant only in the wet season, their water supply being too scarce and too saline to be adequate for use in the dry" (Pearsall, 1957), which are only grazed by game in the wet season, and then by several hundred thousand head.

Turning now to the immediate stimuli which make the animals collect together and start migrating, there are probably several. As the dry season progresses, grazing becomes increasingly dry and tough and green vegetation is eagerly sought after. The behaviour of two tame springbok and a gemsbok kept in the camp at Okaukuejo illustrates this nicely. The animals lived on the natural veld enclosed by the camp fence and as the area is large there was no question of undernourishment. Yet as the dry season continued they paid much attention to garden trees, shrubs and creepers and nibbled all the green leaves and shoots they were able to reach, although most of the plants were foreign to the Park and unknown to the animals. Indeed strong measures were needed to prevent total destruction of the garden. The quality of the drinking water at many of the holes in the d.s.c.a. probably also worsens during the course of the dry season. The pools gradually decrease in size and through daily use they become muddy and sullied with excrement. It seems likely that those with saline water show a rise in the concentration of salts due to evaporation.

We believe that the steadily depreciating quality of grazing and water has a cumulative effect, building up the animals' receptiveness to any stimuli that might indicate a change. When rain does come it is probably smelt over a great distance. Man with his poor nose can detect a shower for several miles, as I have found by personal experience. Most other mammals can almost certainly do much better. Thus smell and some sort of memory of the direction in which succulent grazing was found in the previous year could bring about movement.

A final point calling for discussion is the origin of the animals found in the w.s.d.a. during the rainy season. Probably some springbok are resident throughout the year. We have seen that game numbers decrease in the d.s.c.a. during the rains and as a migration back to this tract has been observed it is certain that some of the resident herds move westward to the w.s.d.a. But can these two sources account for all the migrants? It does not appear so. We have already mentioned a report that wildebeest were seen trekking northwards in March, 1958. It has been established that these animals are abundant in southern Ovamboland in the dry months. Late in October, 1957, approximately 10,000 were seen there on a patch of burnt grassveld some 10 miles square. We know that the plains of Ovamboland are dominated by perennial grasses and that they are often flooded in wet weather, a com-

bination of circumstances which would make them unattractive to game at that season. The evidence points to the probability that some of the game, or at least some of the wildebeest, found in the w.s.d.a. of the Park comes from Ovamboland.

Namutoni Area and Andoni Flats

Until the appointment of a ranger at Namutoni in May, 1957, no continuous record of the animal life in that sector was available. This account has been compiled chiefly from his monthly reports.

Elsewhere in this paper the vegetation and soils of the tract surrounding Fort Namutoni have been described. The density of the bush beyond the plains bordering the pan and the occurrence of seven permanent waterholes within a radius of about 4 miles of the fort are important influences on the constitution of the fauna. The ubiquitous zebra, wildebeest and springbok are the commonest ungulates but kudu (*Tragelaphus (Sirepsiceros) strepsiceros* Pallas) are probably more numerous here than anywhere else in the Park. Eland and giraffe numbers are also high, elephants (*Loxodonta africana* Blumenbach) were seen consistently throughout most of 1957 and duiker (*Sylvicapra grimmia* Linn.) and Damara dikdik (*Madoqua kirkii damarensis* Günther) are abundant only in this part of the Park. Gemsbok are however very scarce indeed.

The reports for July, August and September show that large ungulates and particularly the three migrant species were abundant during the dry season. The first rain fell in October, upon which "literally thousands of springbok, zebra and wildebeest" invaded the plains around the fort. Possibly those resident in the eastern part of the d.s.e.a. were responsible for this congregation; alternatively there may have been a southward movement from Ovamboland. In November good rains fell and the grazing was green and succulent. Wildebeest and springbok were still abundant but both here and on the Andoni flats zebra became remarkably scarce. In December the numbers of all three species again reached a high level around Namutoni and conditions remained thus in January and February.

These notes show that the only indications of a migration were an increase of zebra, wildebeest and springbok after the first rains and a scarcity of the former in November. Until detailed information is available for a longer period, it would be unwise to formulate general conclusions on the movements of ungulates in the Namutoni area.

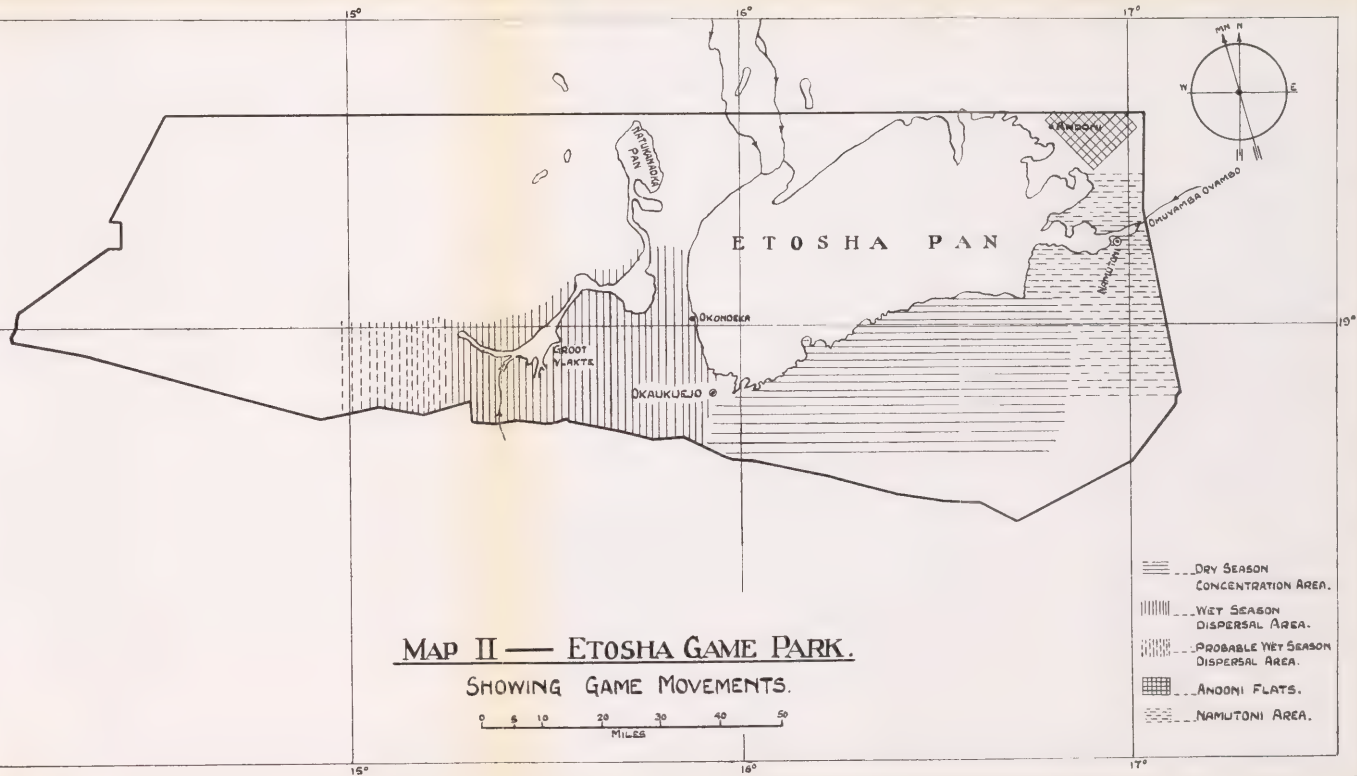
During the dry season the Andoni flats do not seem to support a large resident game population. At the end of the rains, when the grass was green and rainwater still abounded (30th April, 1957), 1,000-1,500 wildebeest, several hundred zebra and perhaps 100 springbok were seen there. On 20th October only a few head were observed. On 24th October, however, 304 wildebeest and 469 zebra were counted from the road—an immigration was apparently under way. When the ranger next patrolled the flats on 1st November, he counted 2,435 zebra about Andoni waterhole and a further 71 wildebeest and 621 springbok on the plains. Later in the month (date not given) he saw only a few hundred springbok. It was at this time that zebra became scarce at Namutoni.

Another immigration must have taken place because on 28th December between 5,000 and 6,000 wildebeest, but very few zebra and springbok, were grazing on the flats. They moved away again and on 19th January, 1958, only 20 wildebeest were noted. From that date until the end of February the game population remained at this low level.

Thus it appears that big herds do occupy the flats intermittently during the rains. The plain has the status of a w.s.d.a. at times but more information is needed to understand game movements here fully.

Summary

Observations on the ecology of the Etosha Game Park, a sanctuary in South West Africa, are recorded. A short description of the climate, topography, soils, vegetation and water



supplies of the Park is given. Marked differences were found between the distribution of the dominant ungulates, zebra, wildebeest and springbok, in the dry season (May-September) and in the wet season (October-April): they confirm, in the main, the general descriptions of two older workers. In the dry months the bulk of these animals range over a dry season concentration area characterised by long perennial grasses and abundant surface water. After the onset of the rains most migrate westwards to a wet season dispersal area with annual grasses and temporary rainwater pools. Here they are probably joined by others, perhaps mainly wildebeest, which migrate southwards from the Ovamboland Native Reserve. Here also parturition occurs. The hypothesis that the migration is primarily a response to differences in the palatability of the grazing and the availability of water in the two areas concerned, is put forward. Other large ungulates which appear to perform more or less regular, but as yet poorly understood, seasonal movements are gemsbok, giraffe and eland. The status of some parts of the Park in relation to game migration is doubtful or unknown.

Acknowledgments

It is a pleasure to express my thanks to those people who assisted me in various ways, either in carrying out this study or in the preparation of the results for publication. I am much indebted to Mr. B. J. G. de la Bat, Chief Game Warden for South West Africa, for help and encouragement freely given while I worked in the Park and since, and to his wife for many kindnesses. My erstwhile colleagues, particularly Mr. C. J. V. Rocher of Namutoni, provided a good deal of information by supplying detailed field notes. The Secretary for S.W.A. kindly gave permission to use information contained in departmental reports. The Surveyor-General allowed me to copy a map produced in his department. Special thanks are due to Mr. John Davies for his ready assistance in solving the problems of mapping and to Mrs. E. Grenfell for the fine maps she has drawn. Messrs. C. J. Skead and D. H. S. Davis and Dr. R. Bigalke kindly read the original manuscript from which this paper was prepared and made helpful suggestions. Mr. O. A. Leistner drew my attention to a useful reference and read this manuscript. Finally, I record my gratitude to my wife for invaluable general help and for typing the manuscript.

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